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ABSTRACT

A survey was sent to the principals of all regular public schools in the Cincinnati school district in April 1986 to determine the distribution of instructional computers in the schools and to examine the relationship of computer distribution to other school characteristics. Responses to the questionnaire were broken down by elementary, middle/junior high, and senior high school levels, and analyzed for total numbers of microcomputers, distribution of models of microcomputers, average number of computers per school, and number of students per computer. Data on the following school characteristics were then statistically correlated with the total number of microcomputers and the student to computer ratio for each school: (1) school size, as measured by average daily membership; (2) percent of minority students; (3) percent of low income students; (4) percent of alternative students; (5) school attendance; (6) reading and mathematics achievement as measured by the California Achievement Tests; and (7) per pupil expenditure. For the district as a whole it was found that, although microcomputers were unequally distributed among the schools, the distribution was strongly related to only one of the specific school characteristics examined, i.e., school size. Six references are listed and a table showing the number of microcomputers for each school by computer model is appended. (MES)

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SCHOOL COMPUTER ACQUISITION AND SELECTED SCHOOL CHARACTERISTICS

Paper Presented at the Annual Meeting
of the
American Educational Research Association

April 20, 1987

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Introduction

The Cincinnati Public Schools have been purchasing microcomputers for instructional use since they were first introduced in education in 1979. Individual schools have been acquiring microcomputers based primarily on the resources available to them and on the interest and motivation of the administration and teaching staffs of the schools. This study was done to determine the distribution of instructional computers in the schools and to examine the relationship of computer distribution to other school characteristics.

In April, 1986, the Educational Technology Resource Center sent a survey to principals of all regular schools to obtain a definitive count of the number of microcomputers used for instruction in their schools. Previous counts had been based on records from computer requisitions or staff observations, resulting in a number of inaccuracies. The principal was asked to complete and sign the survey form since some principals had expressed concern in the past about inaccurate records of the number of microcomputers in their schools.

Microcomputer Survey Results

The results of the survey, showing the number of microcomputers reported by the principal for each school, are shown in Appendix A, classified by model of computer. A total of 1,505 instructional microcomputers were reported on the survey, of which 1,028 were Apple computers. There were 144 Tandy/Radio Shack, 183 Texas Instruments, 74 IBM or IBM compatible computers, and 76 other computers. The percentage distribution of these results is illustrated in Figure 1.

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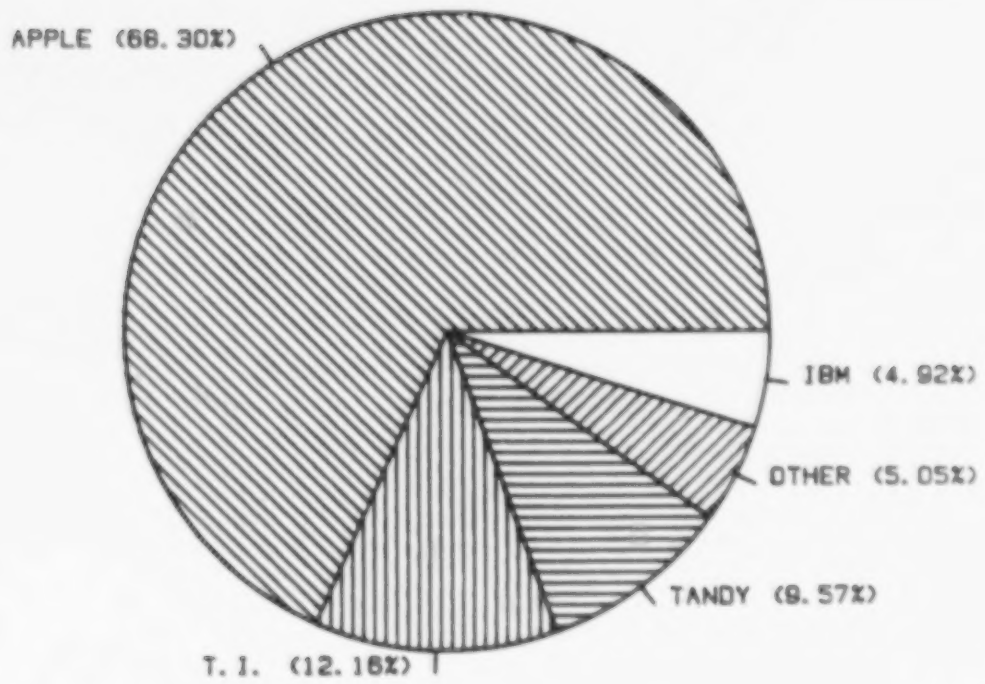
FIGURE 1.

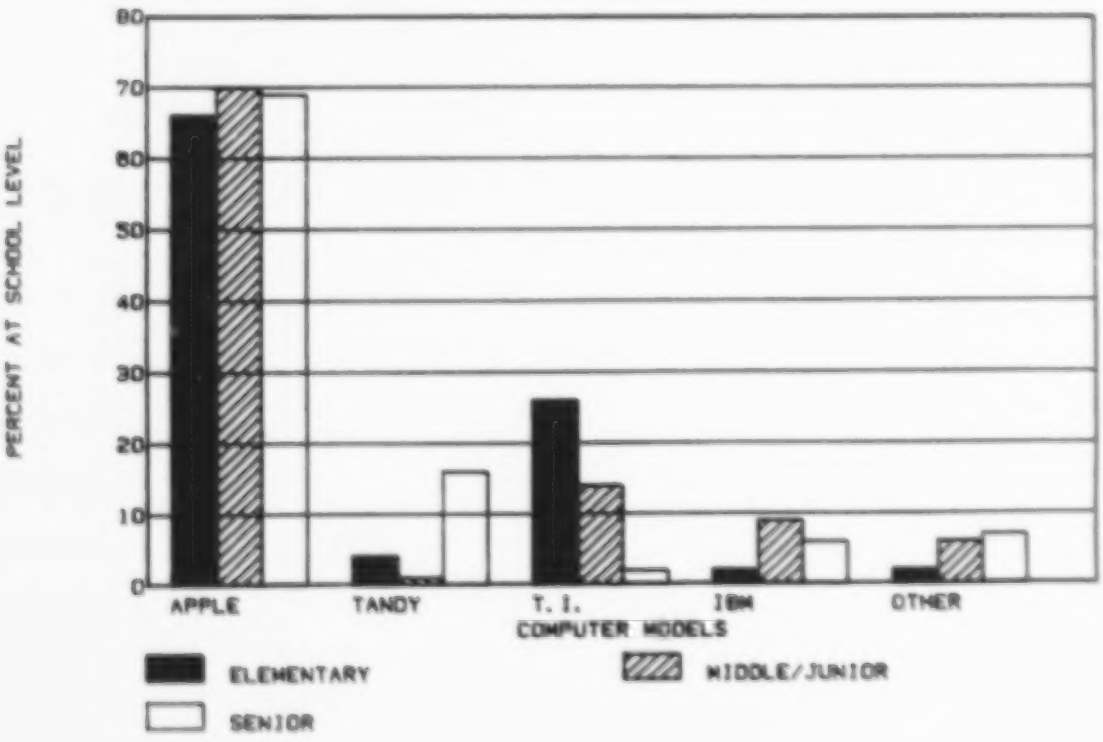


Apple and Tandy/Radio Shack were the first microcomputers to be sold for educational use. The Apple microcomputer has been favored by the schools because it has been the only one for which a large amount of educational software is available. The Tandy/Radio Shack computers have been purchased primarily by the Vocational Education Branch for use in its programs. The Texas Instruments 99/4A was a relatively inexpensive microcomputer purchased by several elementary schools in 1983; however, it was not a commercial success and was eventually discontinued. The IBM micro has not been used much in education until recently as more instructional software has become available for it.

The 'other' category included 16 Atari and 5 Commodore computers, and 24 Xerox computers and 31 Macintosh computers in the Computers Unlimited Program at Hughes High School. The high schools also reported 65 terminals used for teaching word processing in their vocational programs. These were not included in this study because they are not microcomputers.

The survey results were grouped by the elementary, middle/junior high, and senior high school levels. The district classifies the School for the Creative and Performing Arts and the Cincinnati Academy for Physical Education as senior high schools even though they contain elementary and middle school grades. The percentages of microcomputers at each school level are shown in Figure 2.

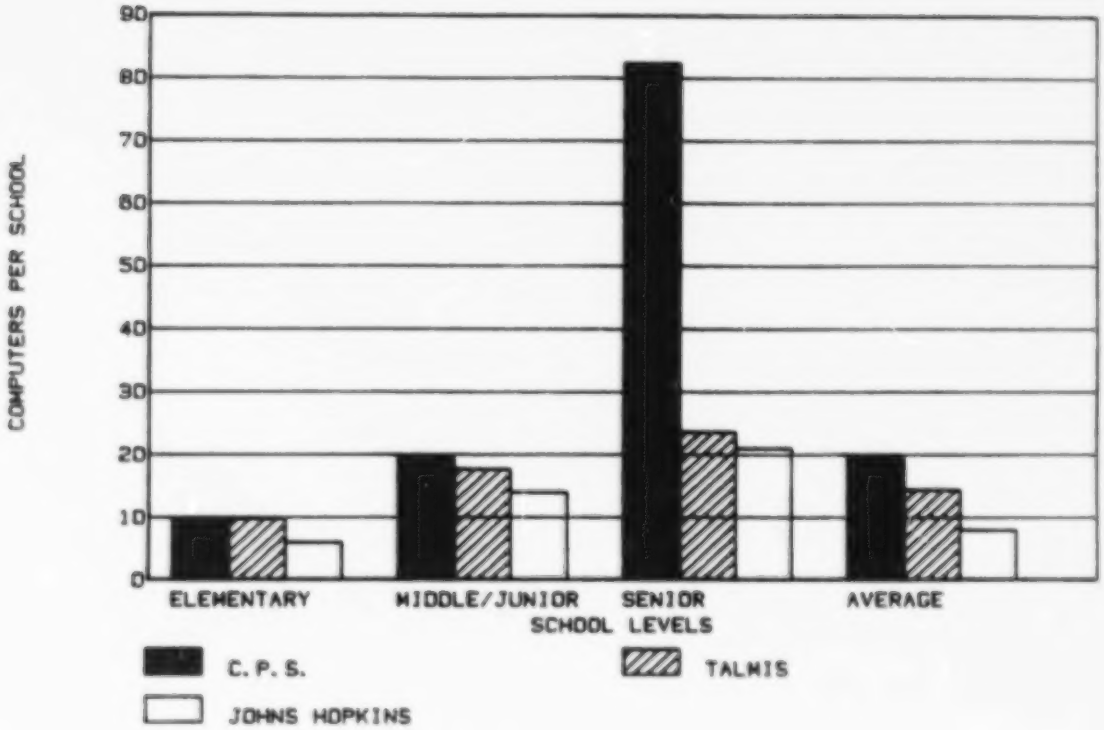
FIGURE 2.



The results illustrated in Figure 2 show that Apples comprise about two-thirds of the instructional computers at all three school levels. The chart in Figure 2 also reflects the purchase of Tandy/Radio Shack computers for the senior high school vocational programs and the purchase of the defunct Texas Instruments micro by elementary schools as described previously.

The total number of microcomputers at each school level shows that about 37% (550) of the computers were at the elementary level, 14% (214) at the middle/junior high level, and 49% (71) at the senior high school level. The total number of computers at each level was divided by the number of schools at the level to obtain the average number of microcomputers per school. The results for the Cincinnati Public Schools were compared with the results from two national studies of microcomputer usage in school districts conducted by Talmis Inc. and the Center for Social Organization of Schools at Johns Hopkins University. Both studies were reported in Spring, 1986 and were based on data from the 1984-85 school year. These results are illustrated in Figure 3.

FIGURE 3.



The average number of microcomputers per school at each school level in Cincinnati was 9.5 at the elementary level, 19.5 at the middle/junior high school level, and 82.3 at the senior high school level. These results compare very favorably with the results from the two national studies as illustrated in Figure 3. The much higher finding of 82.3 computers per school at the senior high school level for Cincinnati reflects both the greater resources for purchasing microcomputers available to the senior high schools because of the vocational programs and the large number of computers at Hughes High School in the Computers Unlimited program. However, subtracting the

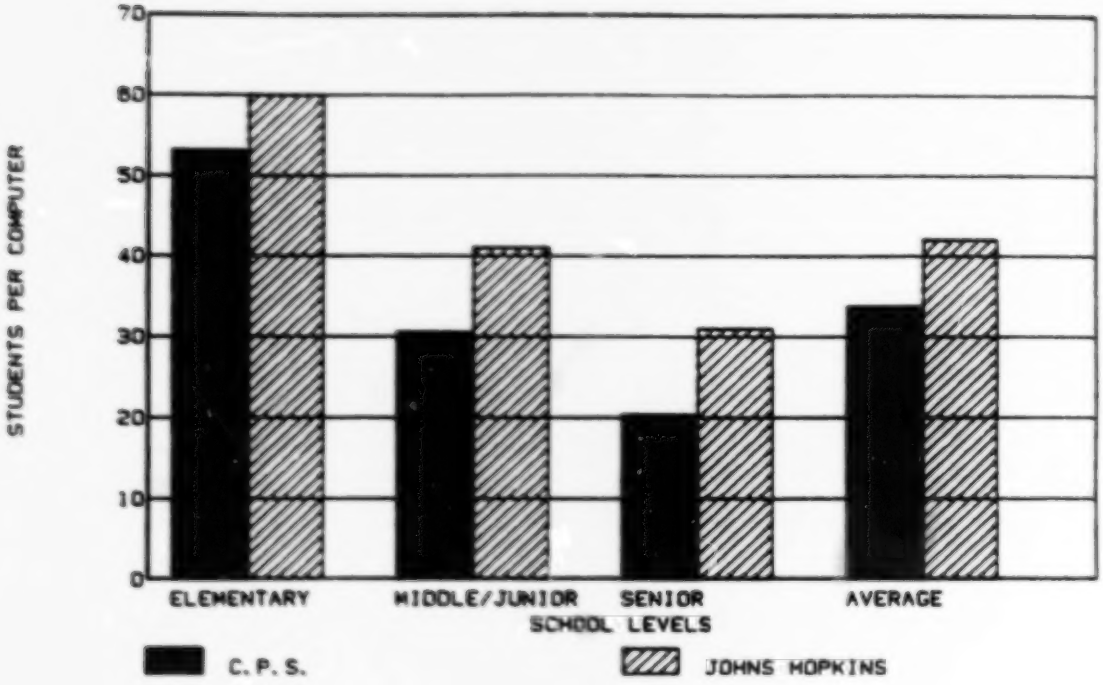
excess computers at Hughes from the the data still leaves an average of 53 microcomputers per school at the senior high school level.

The results in Appendix A show a great deal of variation among the schools in the number of microcomputers. At the elementary level, the number of microcomputers in schools ranged from none to a high of 53; however, 45 of the 53 computers in that school were the Texas Instruments 99/4A. The next highest number of computers, in two schools, was 24. Twenty-two of the 58 elementary schools (39%) had 5 or fewer computers in their buildings; 3 schools reported having only one microcomputer.

At the middle/junior high school level, one school reported one microcomputer and one school had 47. At the senior high school level, one school reported 9 microcomputers while Hughes, which has the Computers Unlimited Program, had 208; the next highest number of microcomputers among the senior high schools was 130.

To further examine the distribution of microcomputers in the schools, the number of students per computer in each school was calculated. This would allow comparisons among schools of different sizes. These results are shown in Figure 4 for each school level along with comparable data from the Johns Hopkins study.

FIGURE 4.



For Cincinnati elementary schools, the number of students per computer varied from a low of 8.6 to a high of 286 with an average of 53.3 students per computer. Seven of the 58 schools (12%) had ratios of over 200 students per computer.

At the middle/junior high level, the number of students per computer ranged from a low of 12.8 to a high of 384 with an average of 30.5. At the senior high level, the ratio of students to computers varied from a low of 7.2 at Hughes (11.1 at the next lowest school) to a high of 125.2 with an average of 20.3 students per computer. As illustrated in Figure 4, these results compare very positively with the Johns Hopkins results in that Cincinnati shows a lower ratio of students

to computers at all three school levels. However, they also show that the elementary schools have much higher student to computer ratios than the middle/junior high school and senior high school levels.

Although Cincinnati compares well with the national averages for number of microcomputers per school and number of students per computer, the actual distribution of microcomputers varies widely from school to school. There is also a significant difference between the elementary and secondary levels in the ratio of students to computers. To determine whether the differences in microcomputer distribution are related to other school factors, a correlation study was done; the results are reported in the next section.

Correlation Results

The second part of this study focused on the relationship of selected school characteristics to both the number of microcomputers per school and the ratio of students to computers at each school. The school characteristics included school size, as measured by average daily membership; percent of minority students; percent of low income students; percent of alternative students; school attendance; reading and mathematics achievement, as measured by the California Achievement Tests; and per pupil expenditure. Data on these characteristics were obtained from appropriate offices of the Cincinnati Public Schools. The data were statistically correlated with the total number of microcomputers reported for each school and with the student to computer ratio computed for each school.

The results of these correlation analyses are shown in Tables 1 and 2 for the three school levels and for all schools taken together. The

results for each school characteristic are discussed in the sections following the tables.

Table 1. Correlation Coefficients of School Characteristics with the Number of Computers per School.

	Elementary (N=58)	Middle/Junior (N=11)	Senior (N=9)	Total (N=78)
School Size	.18	.40	.22	.70**
Percent Minority	.22*	.29	.44	.16
Percent Low Income	.02	.29	.05	-.29**
Percent Alternative	-.14	-.56*	-.50	-.17
Attendance	-.09	-.08	-.41	-.44**
Reading Achievement	-.11	-.43	-.42	-.27**
Math Achievement	-.12	-.36	-.46	-.39**
Per Pupil Expenditure	-.03	-.32	.28	.33**

*95%,**99% probability that the actual correlation is greater than zero.

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Table 2. Correlation Coefficients of School Characteristics with the Student/Computer Ratio.

	Elementary (N=58)	Middle/Junior (N=11)	Senior (N=9)	Total (N=78)
School Size	-.11	-.38	-.20	-.26*
Percent Minority	-.17	-.19	-.55	-.19*
Percent Low Income	.17	-.41	-.30	-.16
Percent Alternative	.03	.89**	.76**	.20*
Attendance	-.05	.11	.57	.17
Reading Achievement	-.02	.73**	.63*	.21*
Math Achievement	-.06	.59*	.62*	.19*
Per Pupil Expenditure	-.01	.30	-.31	-.10

*95%,**99% probability that the actual correlation is greater than zero.

School Size. As shown in Table 1, there was a high and statistically significant correlation of .70 for all schools between school size and the number of computers per school. This finding was confirmed somewhat in Table 2 by the significant but low negative correlation of -.26 for the student/computer ratio. Both results indicate that, district-wide, larger schools have more microcomputers for instruction and tend to have lower student/computer ratios. These results confirm the finding noted in the previous section that the middle/junior and senior high schools, which are larger than the elementary schools, have more microcomputers and lower student to computer ratios than the elementary schools. This suggests that microcomputer resources have been concentrated at the two secondary school levels.

Percent of Minority Students. When the percent of minority students in each school was correlated with the number of computers per school, only the correlation of .22 in Table 1 at the elementary level was found to be statistically significant. At the senior high level, a non-significant correlation of .44 was found. These results suggest a slight tendency for schools with more minority students to have more microcomputers. On a district-wide basis, there was a low but significant correlation (-.19) in Table 2 of minority percentage with student/computer ratio, suggesting that schools with more minority students also have fewer students per computer. At the senior high level, the relationship was much stronger (-.55). The overall results show that schools with more minority students have tended to acquire more microcomputers, especially at the senior high school level.

Percent of Low Income Students. The percent of low income students showed a low but significant negative correlation of -.29 with the number of microcomputers indicating a slight tendency for schools with higher percentages of low income students to have fewer microcomputers. At the three school levels, no significant correlations with low-income status were found; nor were there any significant correlations of low-income status with the student/computer ratios. The middle/junior high level did show a moderate but non-significant negative correlation in Table 2, indicating a tendency for schools at that level with more low income students to have lower student to computer ratios. The overall results show that low-income status of the schools is only weakly related to computer distribution.

Percent of Alternative Students. To examine whether the alternative status of schools is related to computer distribution, the percent of

alternative students was correlated with the two microcomputer measures. The results in Table 1 show that alternative status was negatively correlated with the number of computers at the two secondary school levels; the correlation at the middle/junior high school level was statistically significant. This indicates, that at those two levels, schools with more alternative students have fewer computers.

This finding is strongly confirmed in Table 2 where there are high significant correlations of .89 at the middle/junior high level and .76 at the senior high level indicating that schools at those levels with higher percentages of alternative students were very likely to have higher student to computer ratios. However, this result disguises the fact that the 300 students in the Computers Unlimited alternative program at Hughes High School shared nearly 200 computers. Nevertheless, on an overall basis, secondary schools with more alternative students tended to have fewer computer resources. At the elementary level, no such relationship was found.

Attendance. The schools' attendance rates were correlated with the number of microcomputers per school and showed an overall correlation coefficient in Table 1 of -.44, a moderate negative relationship that was statistically significant. This means that on a district-wide basis schools with higher attendance rates had fewer microcomputers. No statistically significant correlations were obtained between attendance and student/computer ratio; however, there was a correlation of .57 in Table 2 at the senior high school level indicating a tendency for schools at that level with higher attendance rates to have higher student/computer ratios. These results again appear to confirm the

previous finding of more computer resources at the secondary level since attendance rates are lower at that level than at the elementary level.

Reading Achievement. The number of microcomputers in schools showed a low but significant negative correlation in Table 1 of -.27 with reading achievement on a district-wide basis. At the middle/junior and senior high school levels, the relationship of microcomputers with reading achievement was higher (-.43 and -.42 respectively) but not statistically significant. These results indicate that schools with lower reading achievement have more microcomputers.

The relationship of reading achievement to student/computer ratios in Table 2 was low and significant (.21) at the district level but it was much higher, and significant, at the middle/junior and senior high school levels (.73 and .63, respectively.) These results indicate there is a tendency district-wide, with a much stronger trend at the secondary school levels, for schools with lower reading achievement to have lower student to computer ratios.

Mathematics Achievement. There was a low but significant negative correlation (-.36) of mathematics achievement with the number of microcomputers in the schools. At the middle/junior high and senior high school levels, there were moderate but not significant negative correlations of -36 and -.46 respectively with mathematics achievement. This indicates that schools with lower mathematics achievement tend to have more microcomputers.

The relationship of mathematics achievement to student/computer ratios was low and significant (.19) at the district level, but it also was much higher, and significant, at the middle/junior and senior high school levels (.62 and .59, respectively.) These results indicate that,

as for reading, there is a tendency for schools with lower mathematics achievement to have fewer students per computer.

The finding of negative relationships between computer distribution and achievement can be explained to some extent by the fact that lower-achieving schools have been more eligible for special state and federal funds that have been allocated toward purchasing microcomputers. The stronger negative relationships at the secondary school levels may also be a result of some schools at that level with higher achievement not having vocational programs or other special resources to direct to computer acquisition.

Per Pupil Expenditure. The measure of per pupil expenditure used in this study includes local as well as special state and federal funds including vocational and special education funds. There was a low significant correlation of .33 found between per pupil expenditures in the schools and the number of microcomputers. This relationship was reversed at the middle/junior high level (-.32) but was not statistically significant. Per pupil expenditures did not show any significant relationships with student/computer ratios. These results confirm the suggestion made above that schools with access to more special funds have tended to purchase more microcomputers.

Conclusions

As always with correlation statistics, it should be cautioned that none of the relationships found in this study can be considered causal; the number of microcomputers in a school does not, in itself, produce changes in attendance, nor in reading or mathematics achievement. The results are merely evidence for a certain relationship and do not mean that microcomputers are responsible for any differences in school characteristics. As noted in many cases, the relationships that were found can be accounted for by other factors not measured in this study.

It should also be noted that the relationships described above are most reliable on a district-wide basis; there is less reliability in the results broken down by school level. The results should certainly not be applied directly to any individual school; they only suggest relationships that are true for the district as a whole.

In summary, the results were as follows.

1. The number of microcomputers reported by the school principals showed an unequal distribution of microcomputers among the schools. There was a great deal of variation in the number of microcomputers from school to school at all three levels.
2. Cincinnati Public Schools compared quite favorably to other school districts on a national level in terms of the number of microcomputers per school and the number of students per computer. There was, however, a large difference in Cincinnati, as there is nationally, between the elementary and secondary levels in the number of students per computer.
3. On a district-wide basis, larger schools had more microcomputers and lower student to computer ratios.

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4. Schools with more minority students showed a tendency to have more microcomputers and lower student/computer ratios. These relationships were stronger at the senior high school level.
5. Schools with more low income students showed a slight tendency to have fewer computers. At the middle/junior high school level, schools with more low income students tended to have lower student/computer ratios.
6. Schools at the secondary level with more alternative students tended to have fewer microcomputers and higher student/computer ratios. Alternative status was not related to computer distribution at the elementary level.
7. On a district-wide basis, schools with higher attendance rates tended to have fewer microcomputers; however, no significant relationship was found between attendance and student/computer ratio.
8. District-wide, schools with lower reading and mathematics achievement had more microcomputers. Schools with lower achievement also had fewer students per computer, especially at the secondary school levels.
9. Schools with higher per pupil expenditures tended to have more microcomputers.

For the school district as a whole, the results reported in this study indicate that, while there was an unequal distribution of microcomputers among the schools in the district, except for school size, the distribution was not strongly related to any of the specific school characteristics examined in this study. Some of these differences in computer distribution were due to the fact that certain schools have access to special funds to purchase microcomputers or have

administrators and staff with the interest and motivation to acquire microcomputers.

The relationships found in the study were low to moderate at best and did not show any strong inequities of microcomputer distribution on the basis of the minority, income, or per pupil expenditure characteristics of the schools. The results did show moderate negative relationships between microcomputer acquisition, alternative status (at the secondary level), attendance, and academic achievement of schools which suggests that schools with lower attendance and achievement have tended to acquire more computers perhaps because they have had more resources allocated to them to do so and/or because they believe microcomputers will be useful in improving attendance and achievement. Alternative schools, especially at the secondary level, have tended to direct their resources to areas other than computer acquisition.

However, the unequal distribution of microcomputers in the school district, while not strongly related to the school characteristics studied here, should be remedied by the adoption of policies and programs to ensure that all students have an equal opportunity to use microcomputers in their educational program. The development and implementation of computer-based programs in the school district should not be dependent on the resources available to the individual school, nor on the interest of school staff members. Cincinnati students will live and work in a society based on access to and use of information made available by computers and they need to have these experiences as part of their instructional program on an equal basis.

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APPENDIX A

Number of Microcomputers per School by Computer Model
(April 1986)

Elementary

	Apple	Radio Shack	Texas Inst.	IBM*	Other
Academy of World Languages/Arts					
Anderson Place	1		20		
Bond Hill	3				
Bramble	4				
Burton	8		45		
Carson	1		3		
Carthage	2				
Central Fairmont	4				
Chase	2		6		
Cheviot	7				
CAPE Primary			1		
Clifton	5	18			
College Hill	13				
Covedale	3	2	7		
Douglass			9		
Eastern Hills	9		6		1
Fairview	3				
Hartwell	3		2		
Hays	7				
Heberle	13			11	
Heinold	5				
Hoffman	13				
Hyde Park	6	1	2		
Kilgour	14		7		
Kirby Road	5				
Linwood	6				
Losantiville	5		4		
McKinley	1				
Midway	1	1	2		
Millvale	3		4		
Mt. Airy	1				2
Mt. Washington	4	2			
North Avondale	12				
North Fairmont	12				
Oyler					2
Parham	10				
Pleasant Hill	8		4		
Pleasant Ridge	1		3		2
Quebec Heights	7		6		
Rockdale	15				
Roll Hill	12				
Roosevelt	3				
Roselawn/Condon	14				1
Rothenberg	11				

	Apple	Radio Shack	Texas Inst.	IBM*	Other
Sands	5				
Sayler Park	3		2		
Silverton	7				
South Avondale	10				
Swifton	2	1			
Taft Elementary	19				
Vine	1				
Washburn	2				
Washington Park	23				1
Westwood	5		8		
Whittier	8				
Windsor	13				
Winton Place	2				
Woodford	7				
Total	364	25	141	11	9
Middle/Junior High Schools					
Bloom	3	2	3		11
Cintl. Bilingual Academy	1				
Crest Hills	15			6	
Dater	14		10		
Gamble	17	1	7		
Merry	29		4	14	
Peoples	20		6		
Porter	14				
Roberts	10				
Schwab	22				
Schroder	4				1
Total	149	3	30	20	12
Senior High Schools					
Aiken	110	5	15		
C.A.P.E.	10		12		
Hughes	135			18	55
S.C.P.A	9				
Taft High	32	25			
Walnut Hills	31	37			
Western Hills	34	25		10	
Withrow	89	9			
Woodward	65	15			
Total	515	116	12	43	55
Totals	1028	144	183	74	76

*Includes IBM and IBM compatible microcomputers